MICROMOUSR

ECE 445 - Team 77
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Petronics
By Sprite Robotics™

Introduction

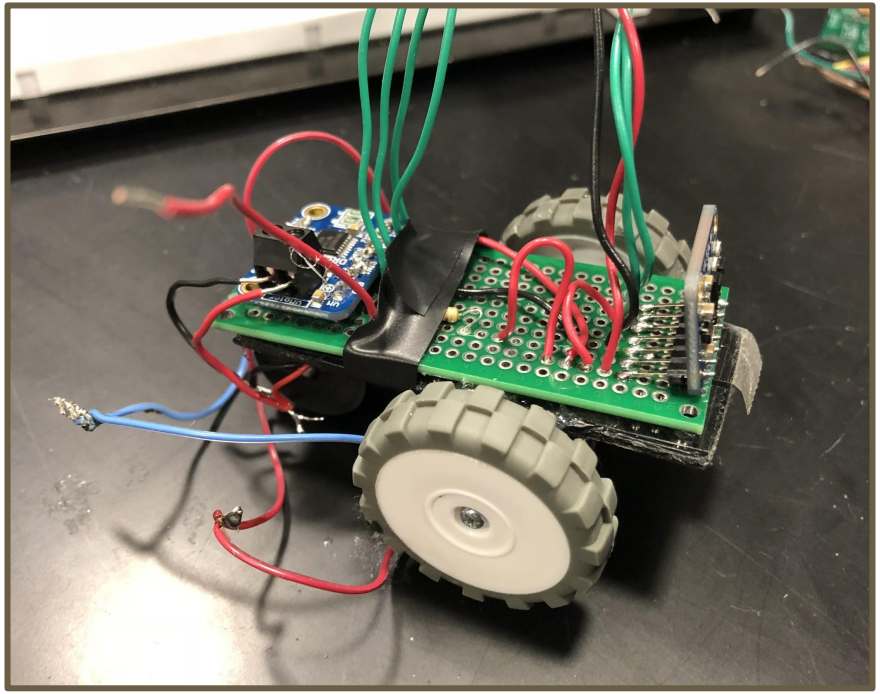
- An innovative startup device.
- A robot cat toy to entertain pets and owners alike.
- Voted Best Cat Toy 2018.

Mousr in Action

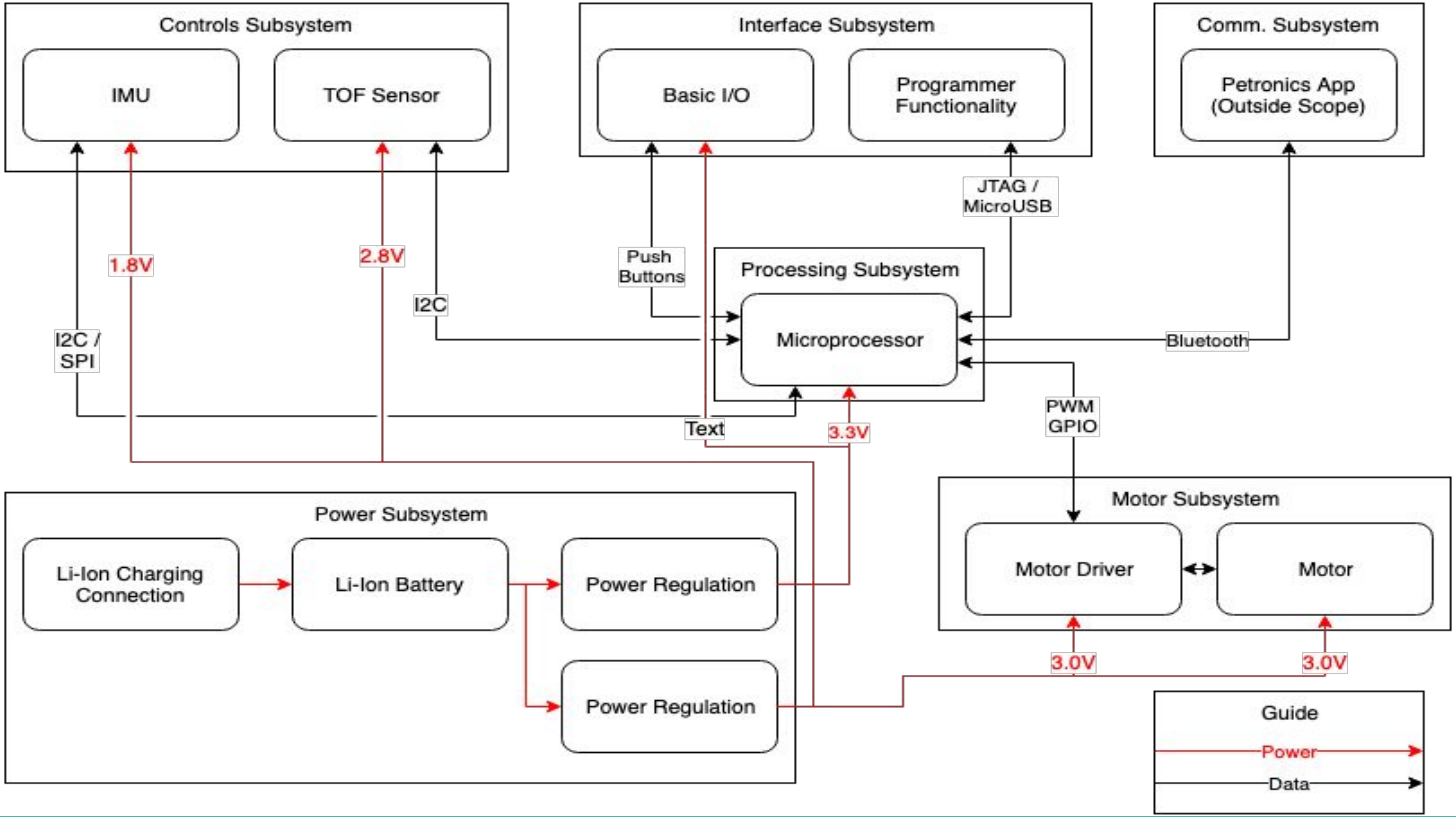
Objectives for MicroMousr

1. Sensor components must exist on one board and be capable of fitting in the physical body of the Mousr product (3.4 x 2.2 x 1.4 inches).
2. Must be able to demonstrate basic movements and control while in Autonomous Mode, and respond to user control when in Manual mode.
3. Electronic components must cost less than the current Mousr model.

MicroMousr System

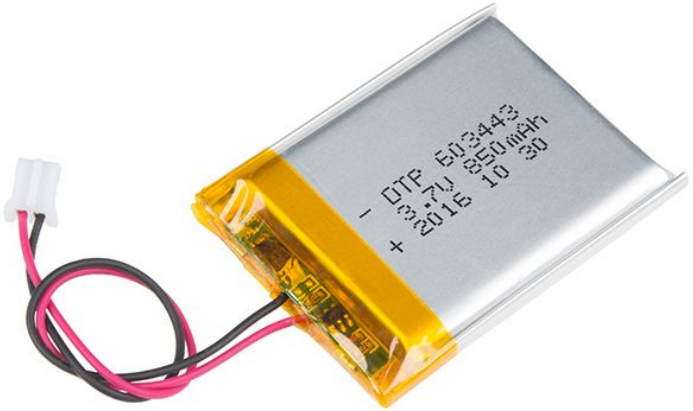


High Level Design



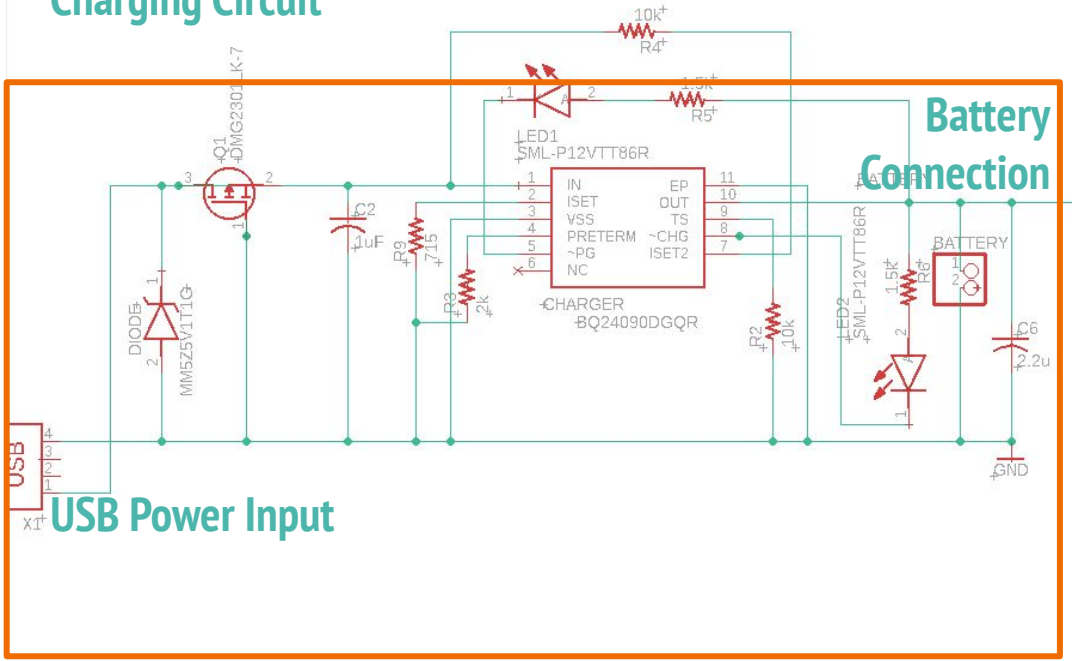
Power

- Power is stored in a 4.2 V battery
- Charging circuit includes reverse voltage protection
- Distributed through two LDO voltage regulators
  - Main components and sensors
- Provides for separate ON and OFF modes



Power Distribution Network

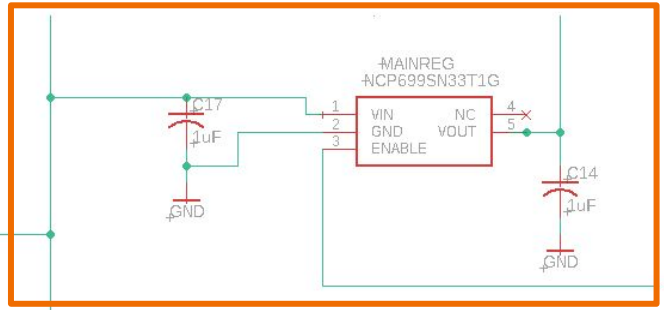
Charging Circuit



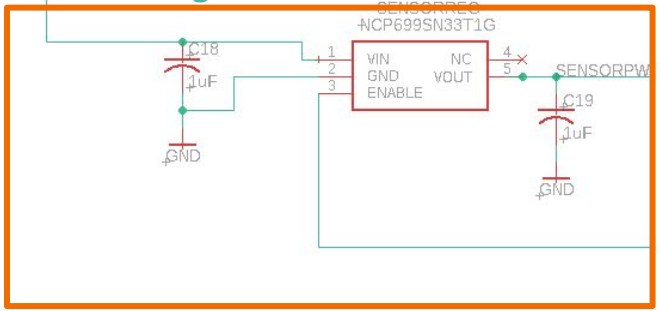
Battery Connection

USB Power Input

Regulator to Processor



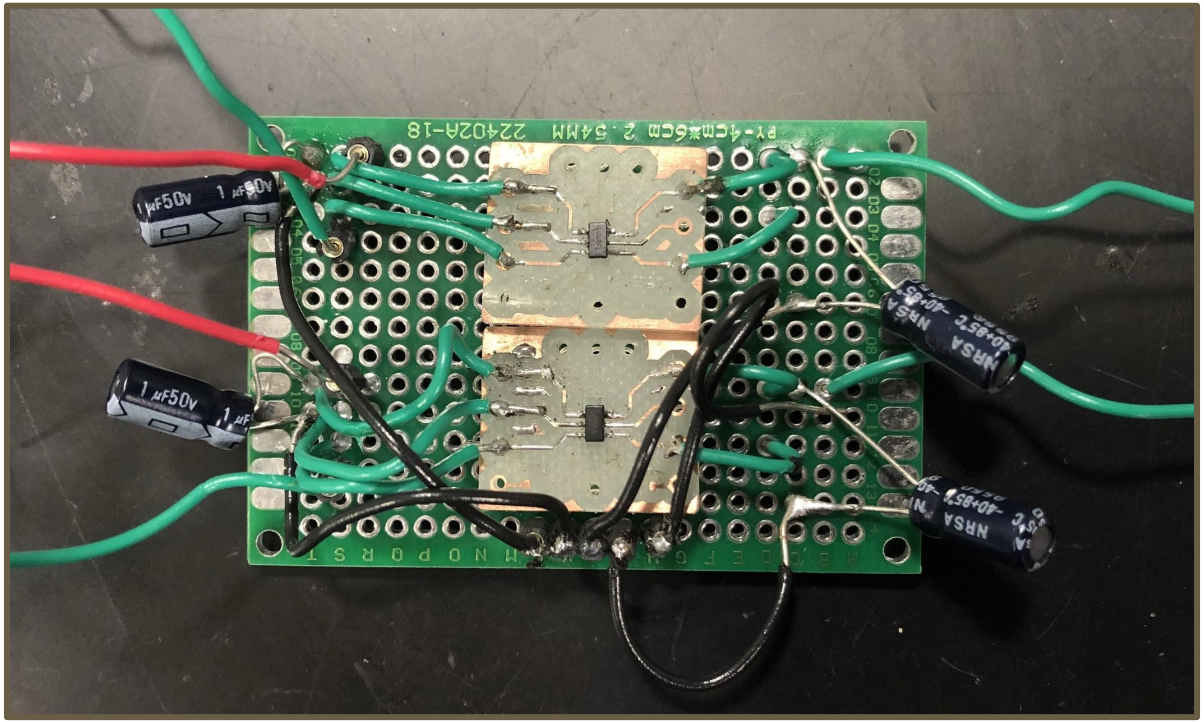
Regulator to Sensors



LDO

Enable

Power from Battery

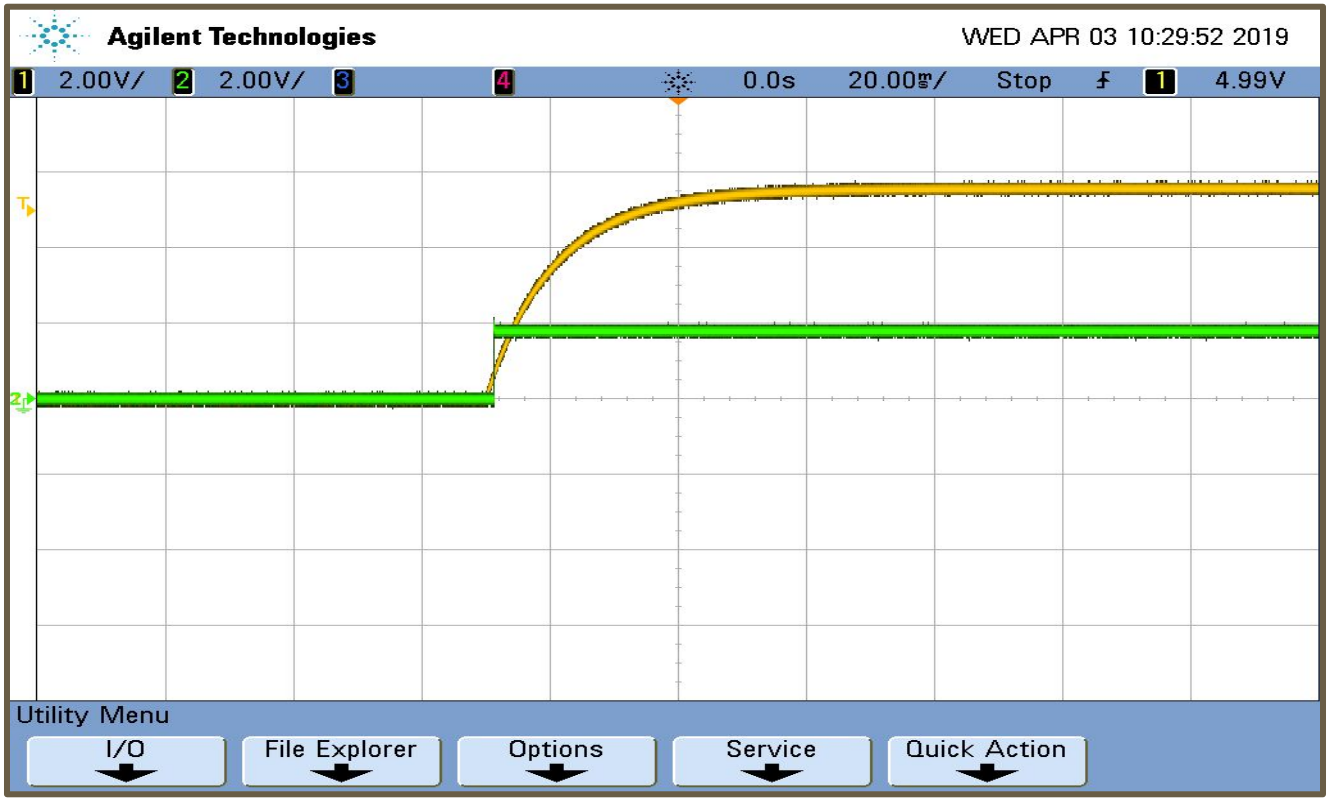


Output to Sensors

Output to Main

Enable

LDO Response Time

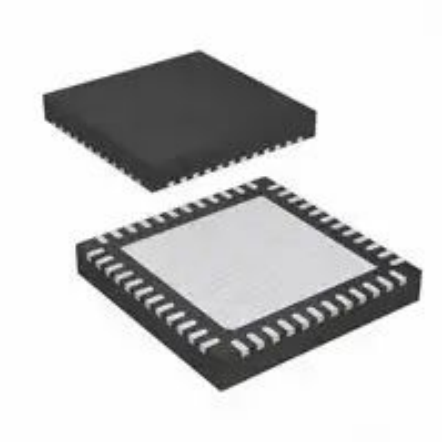


Power Consumption

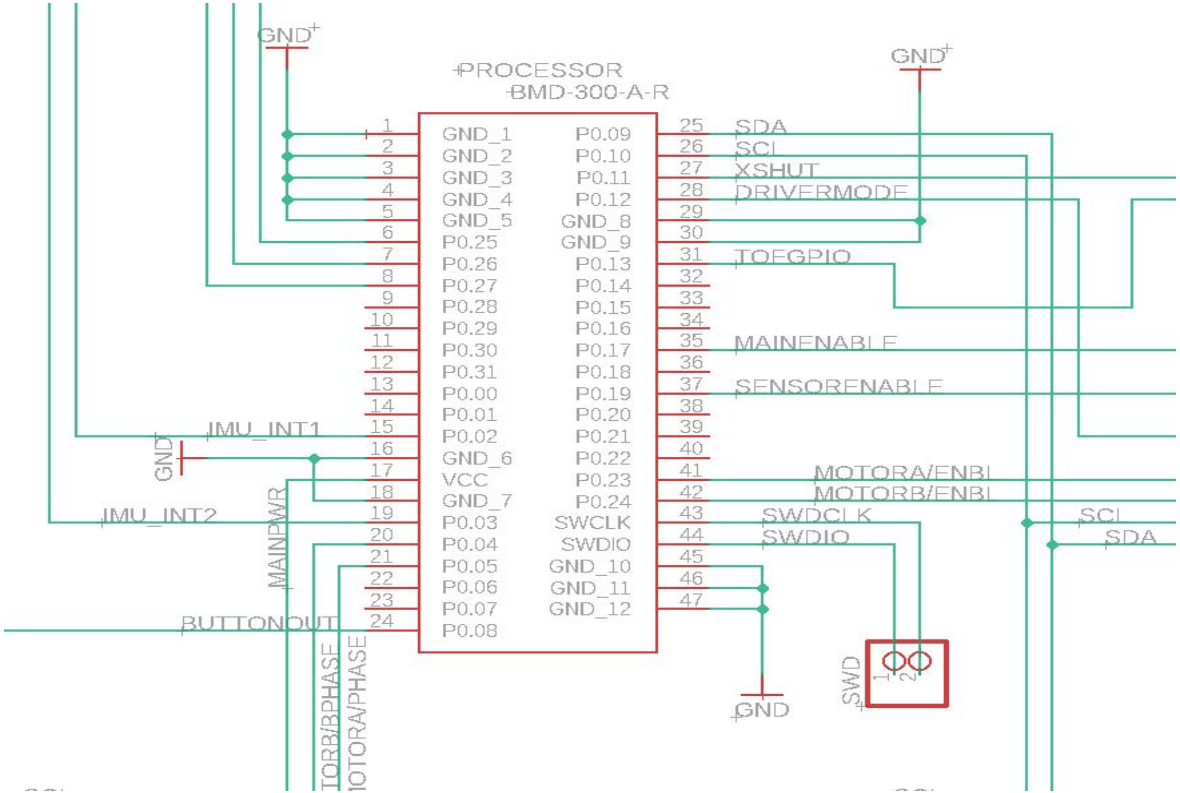
Load	Voltage (Typical)	Voltage Range	Current (Active)	Current (OFF / SLEEP)	Power Consumption (Active)	Power Consumption (OFF / SLEEP)
Processor	3.0	1.7-3.9	5.4mA	.7µA	16.2mW	.0021mW
ToF	+2.8V	2.6V-3.5V	19mA	0A	20mW	0W
IMU	1.8V	1.71V-3.6 V	.45mA	0A	0.81mW	0W
Motor Driver	[Reference **Calculation 2**]				769.2mW	0W
LED	2V	2V-5V	20mA	0A	75mW	0W
Push Button	3V	1V-24V	15µA	15µA	.045mW	.045mW
Voltage Regulator (x2)	4.2V	2.1V-6V	40µA	0A	.168mW	0W
Total Power Consumption					821.186mW	0.05799 mW

Microprocessor

- Cortex-M4 ARM Processor
- Bluetooth Low Energy compatibility

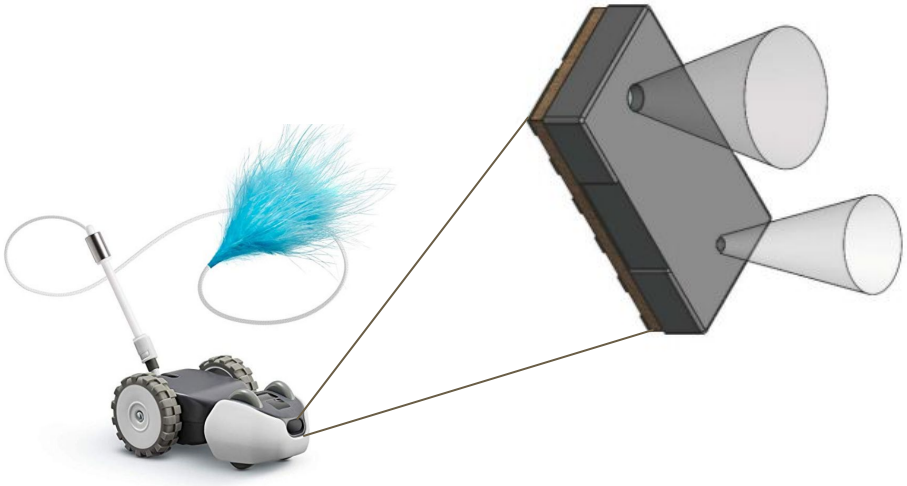


Microprocessor Schematic

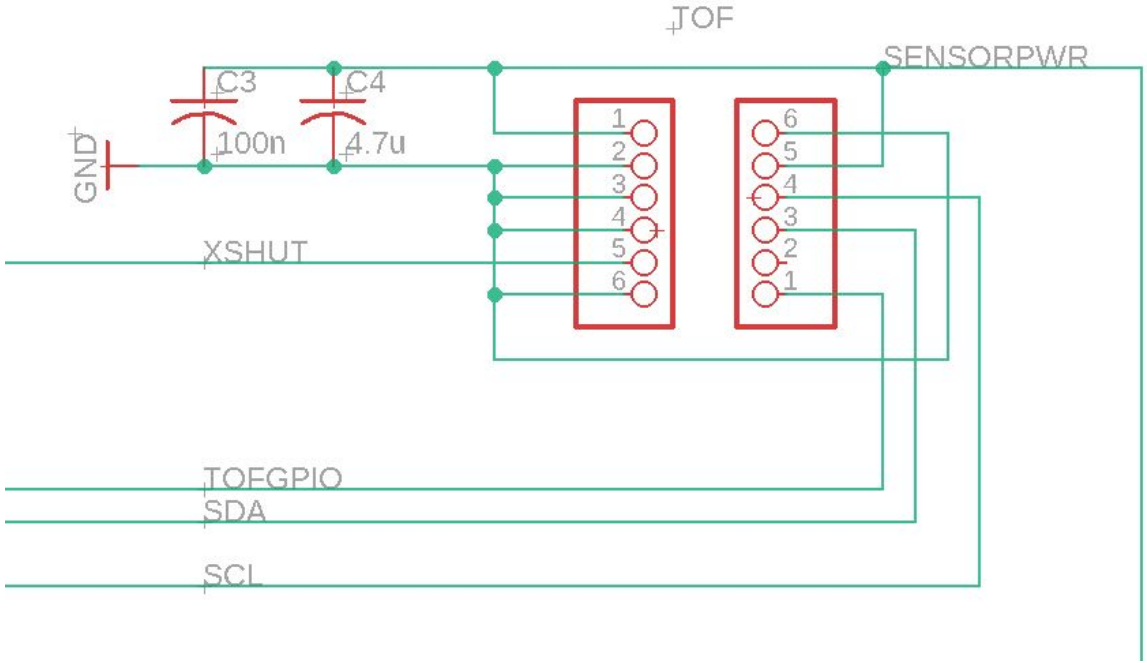


Time of Flight

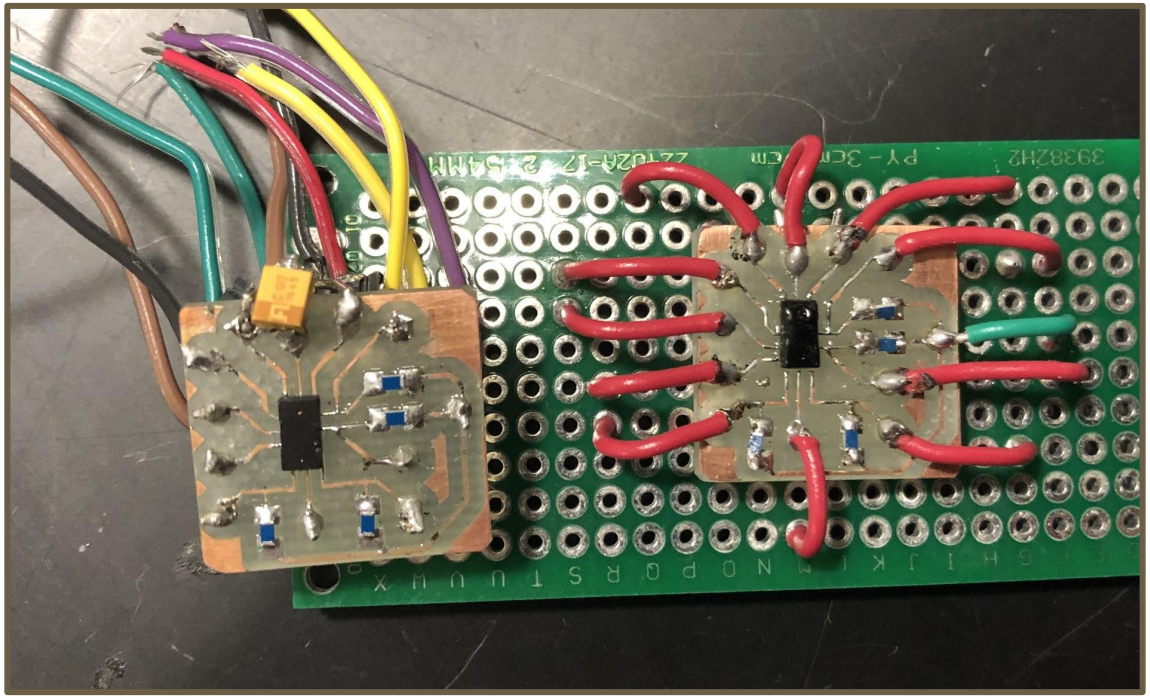
- Optical sensor that uses infrared filters to measure distance
- Used for obstacle avoidance
- Smallest ToF sensor on the market
- Extremely accurate within a 0.7 meter range



Time of Flight

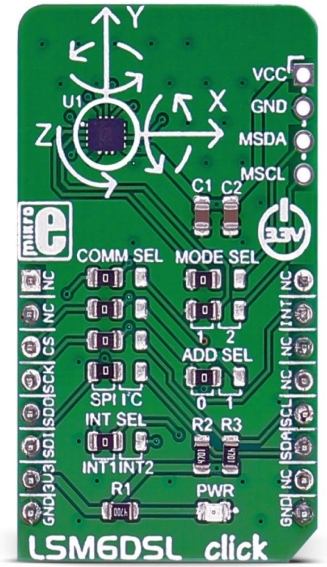


Time of Flight



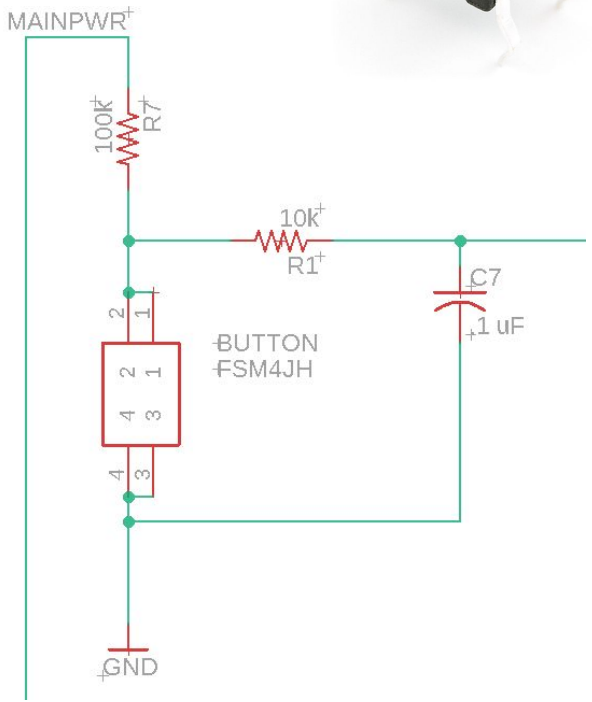
IMU

- Inertial Measurement Unit
- 3-Axis Accelerometer
  - Pitch, roll and yaw are rotation around X, Y and Z axis
- 3-Axis Gyroscope
  - Delivers rotation values for each axis

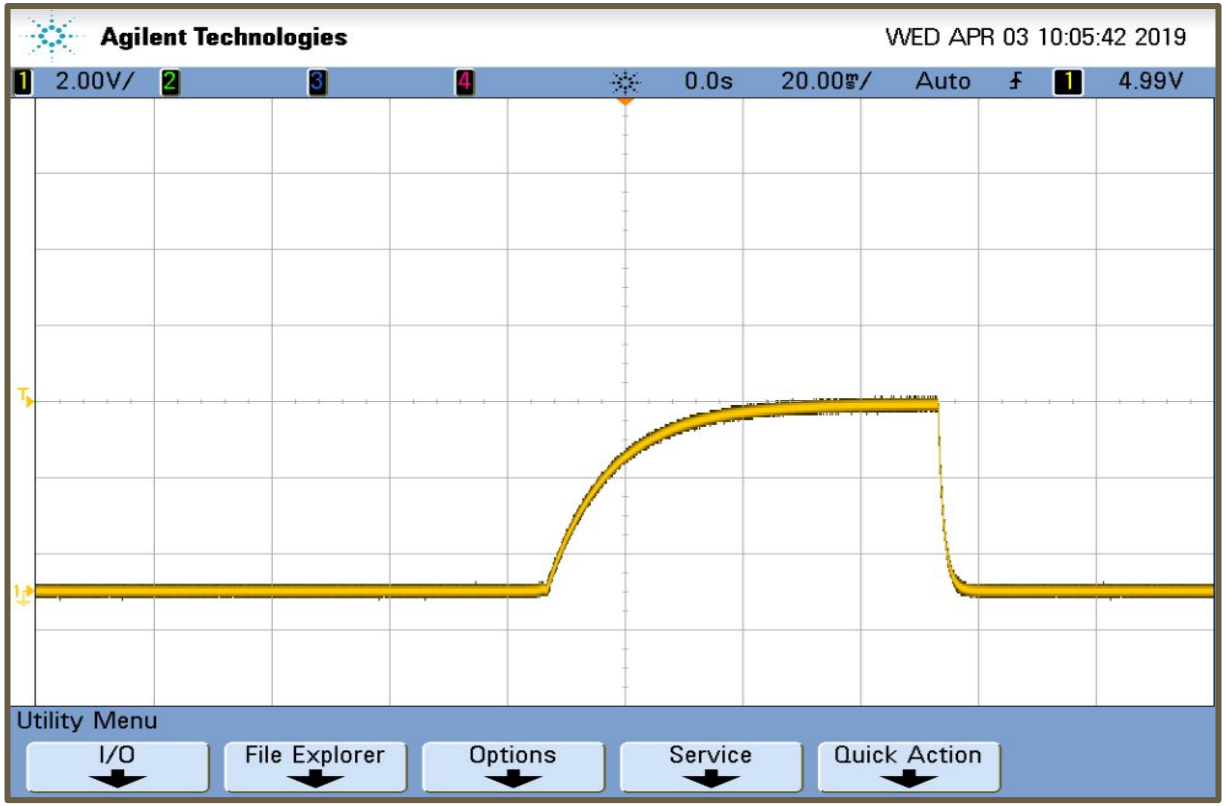


Push Button

- Switch between OFF and ON modes
- Debounce circuit

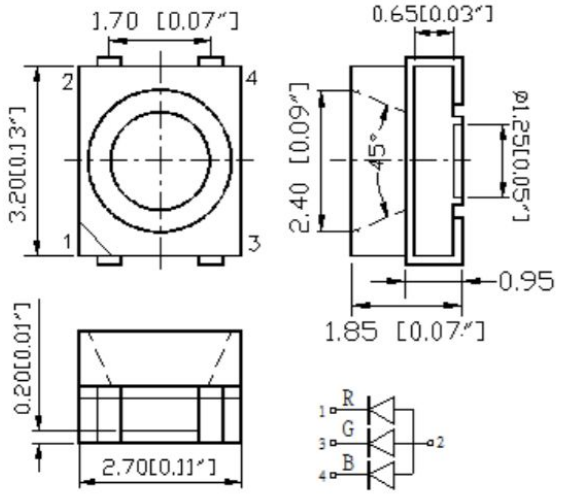


Push Button Debounce

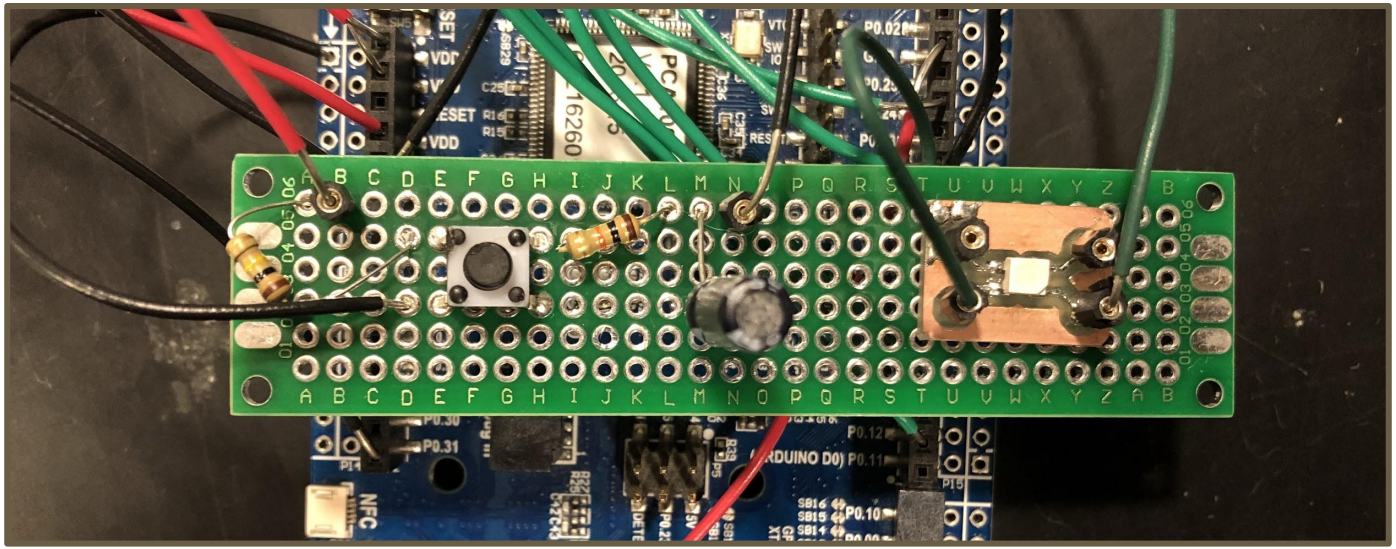


RGB LED

- Signal direction of movement
- PWM Driven

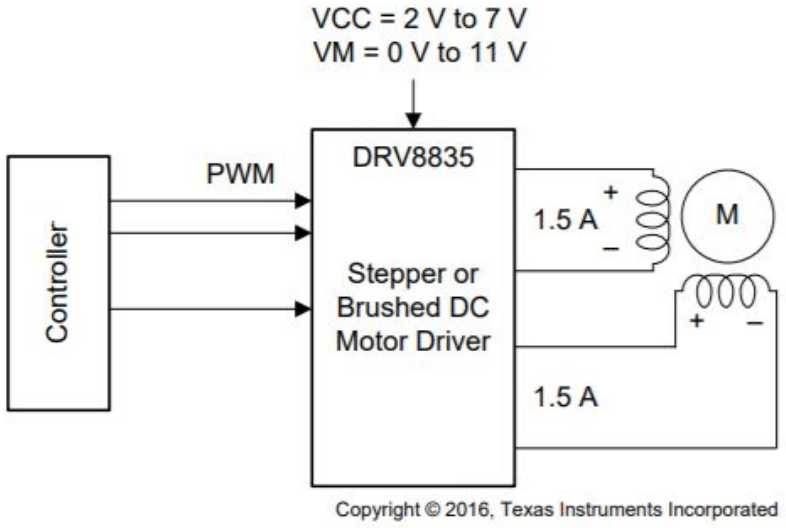


Push Button and RGB

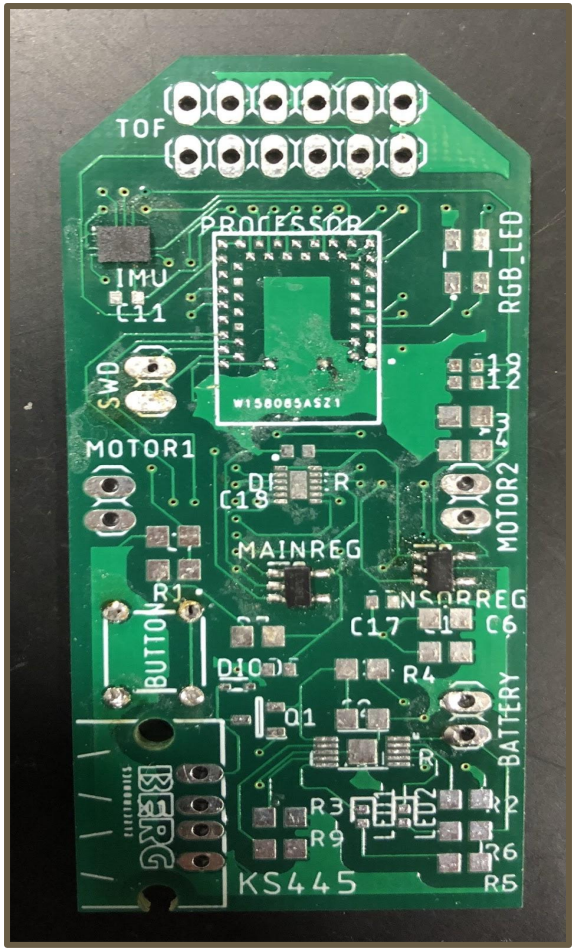


Motor Driver

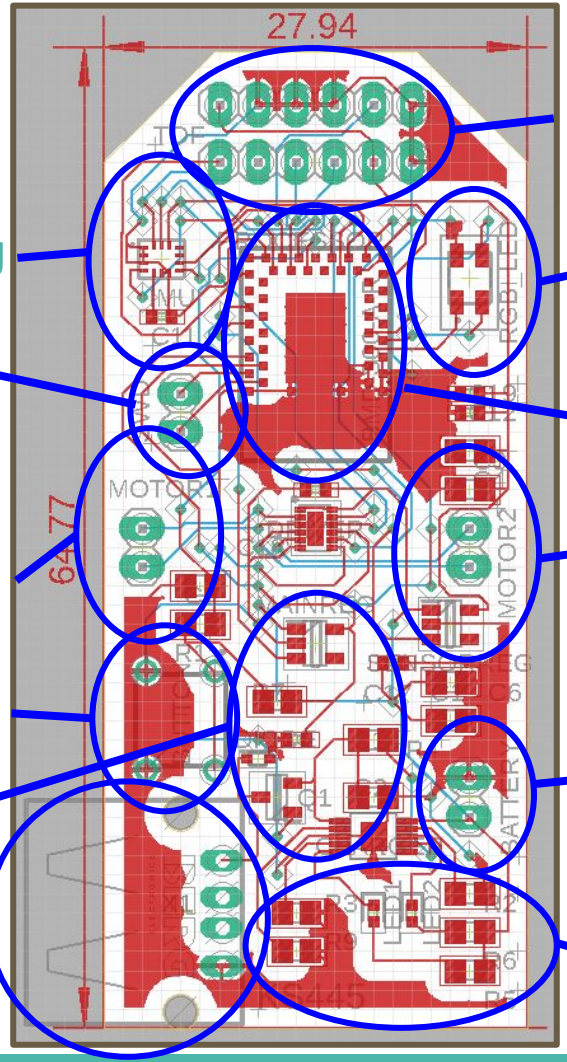
- Dual H-Bridge Chip for two DC motors
- PWM signal from GPIO controls motor direction and speed
- Phase/Enable allows for bidirectional control



Hardware Design

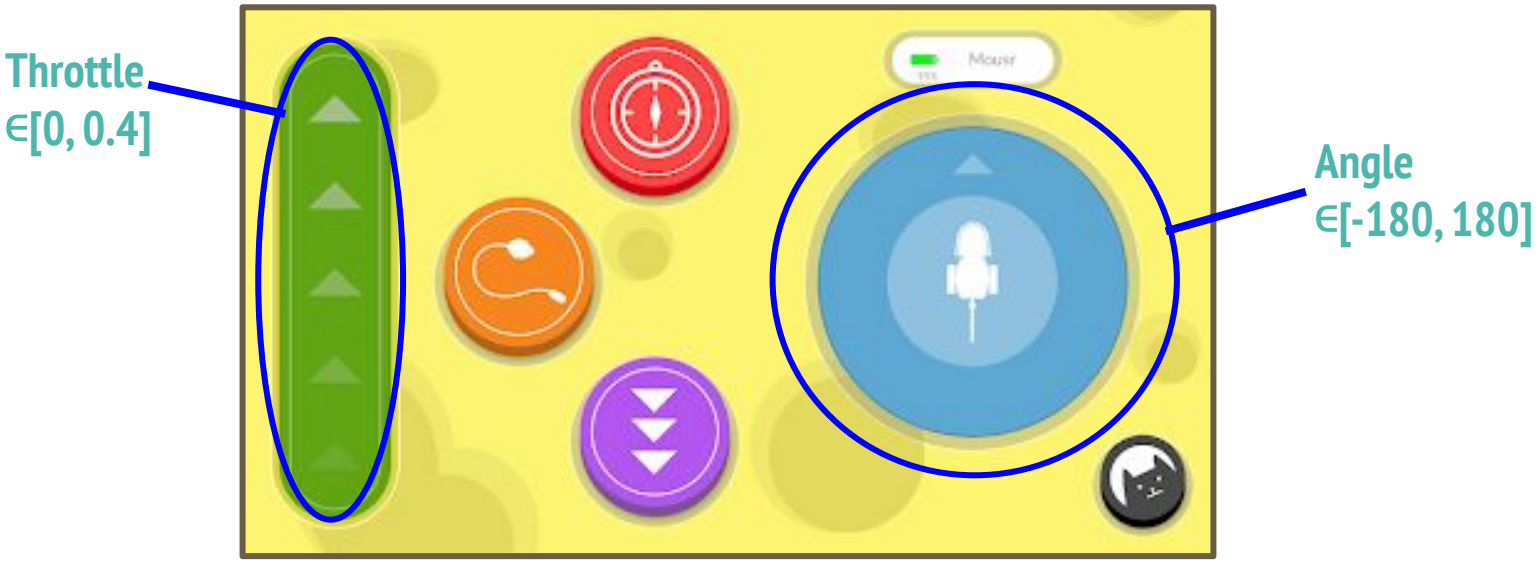


Hardware Design

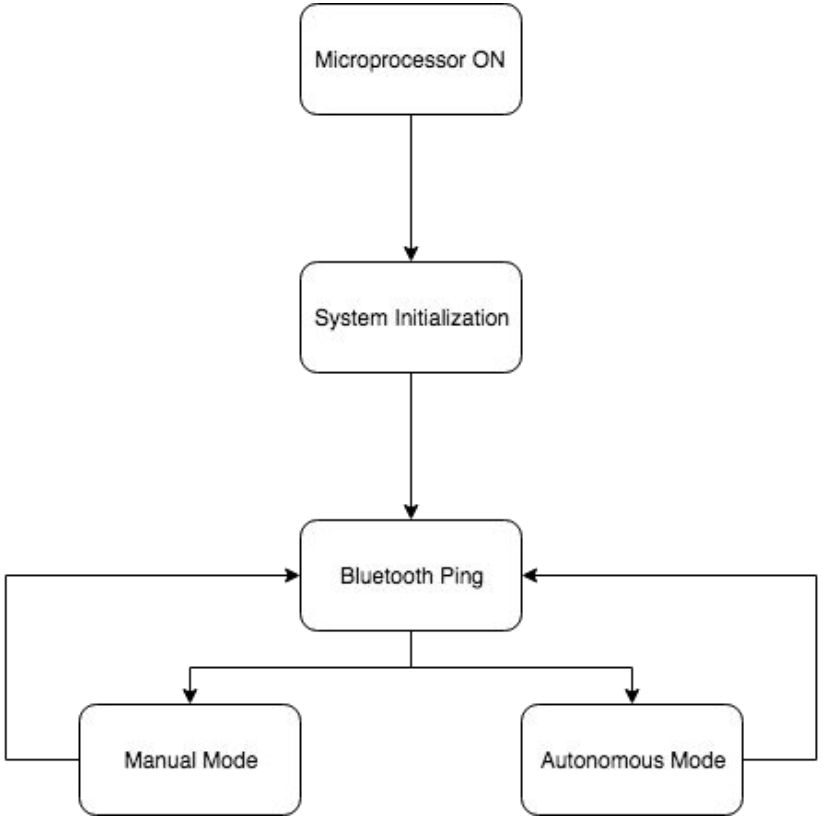


Communication

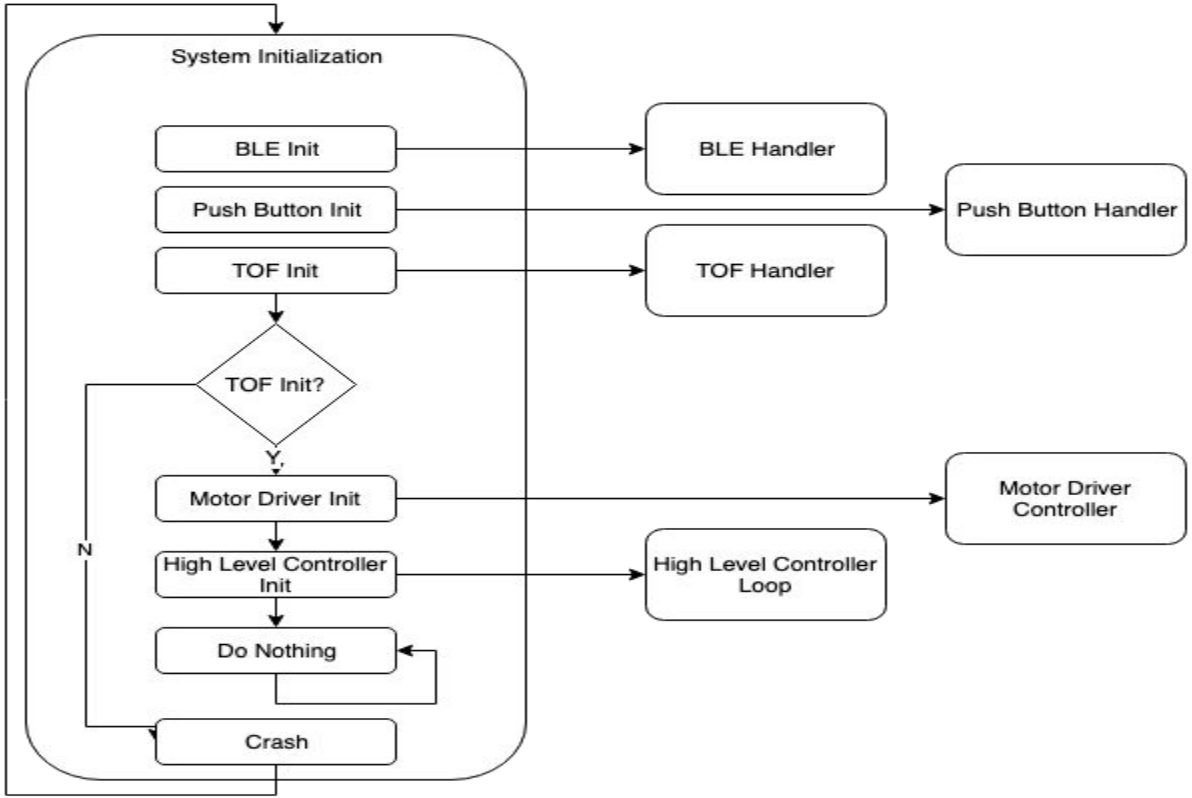
- Bluetooth connection through Petronics app



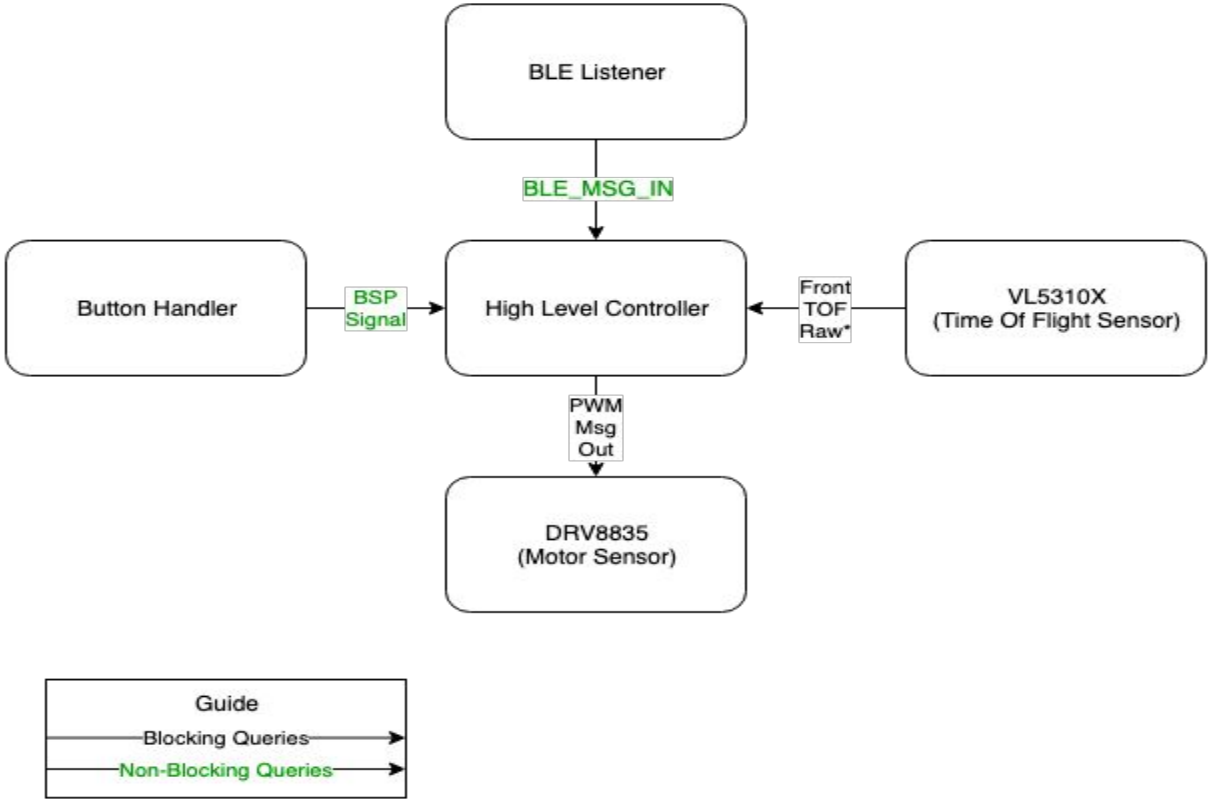
High Level Software



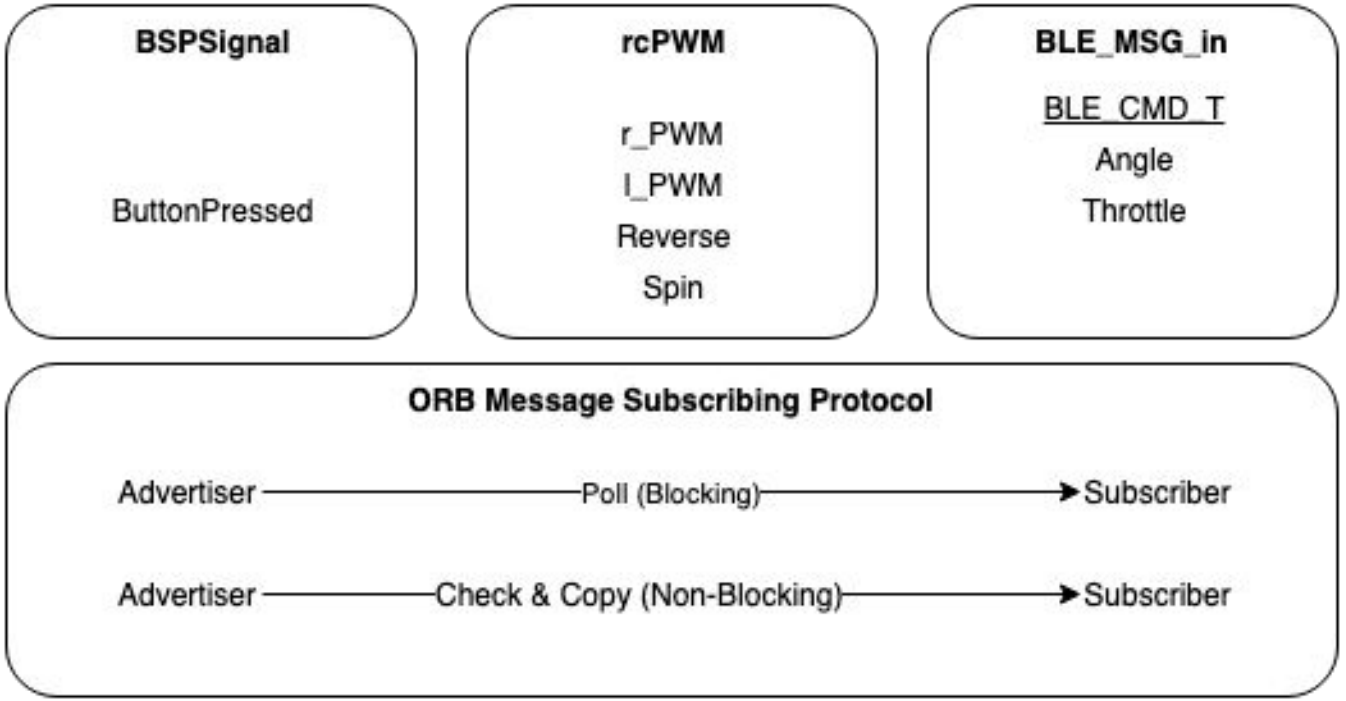
System Initialization Procedure



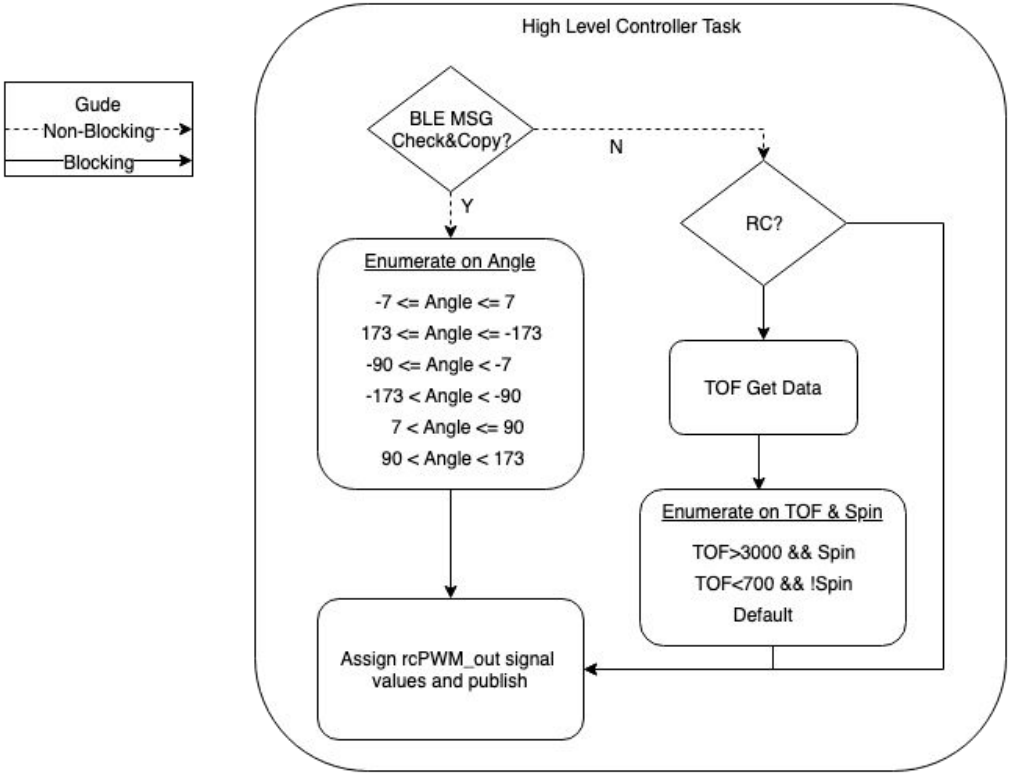
High Level Multithreaded System Description



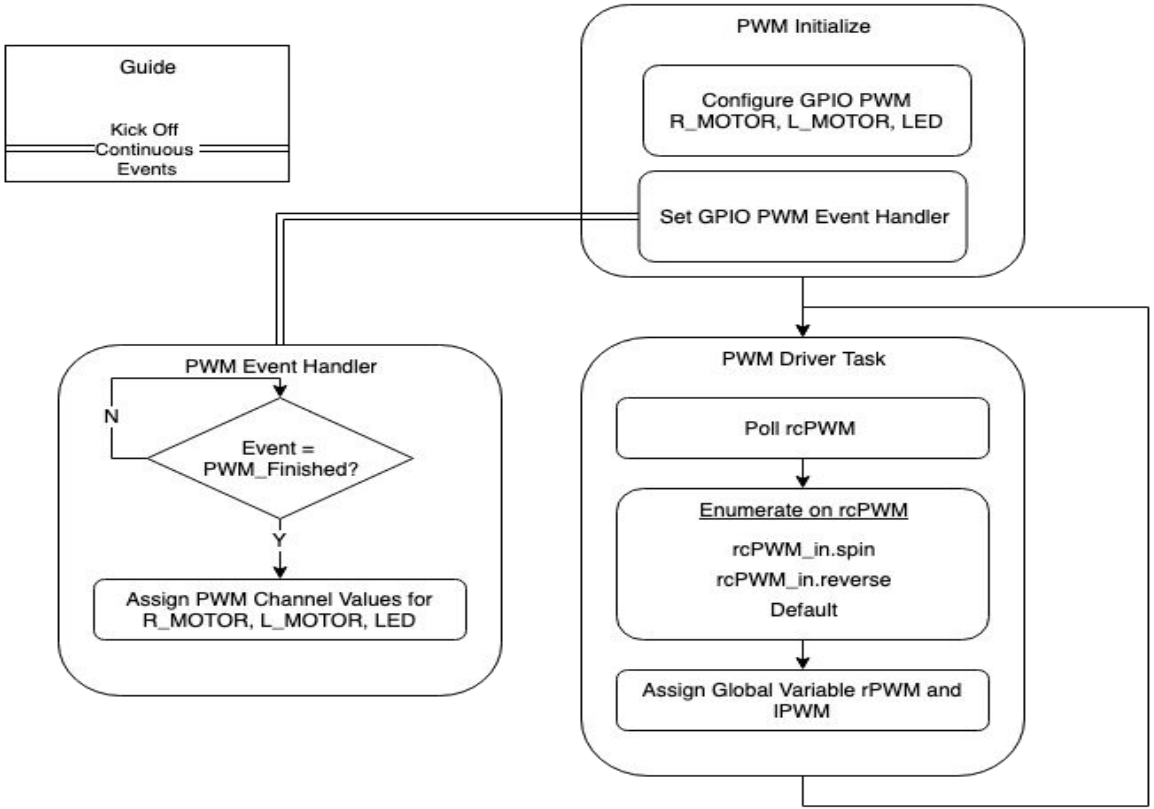
ORB Message Passing Protocol



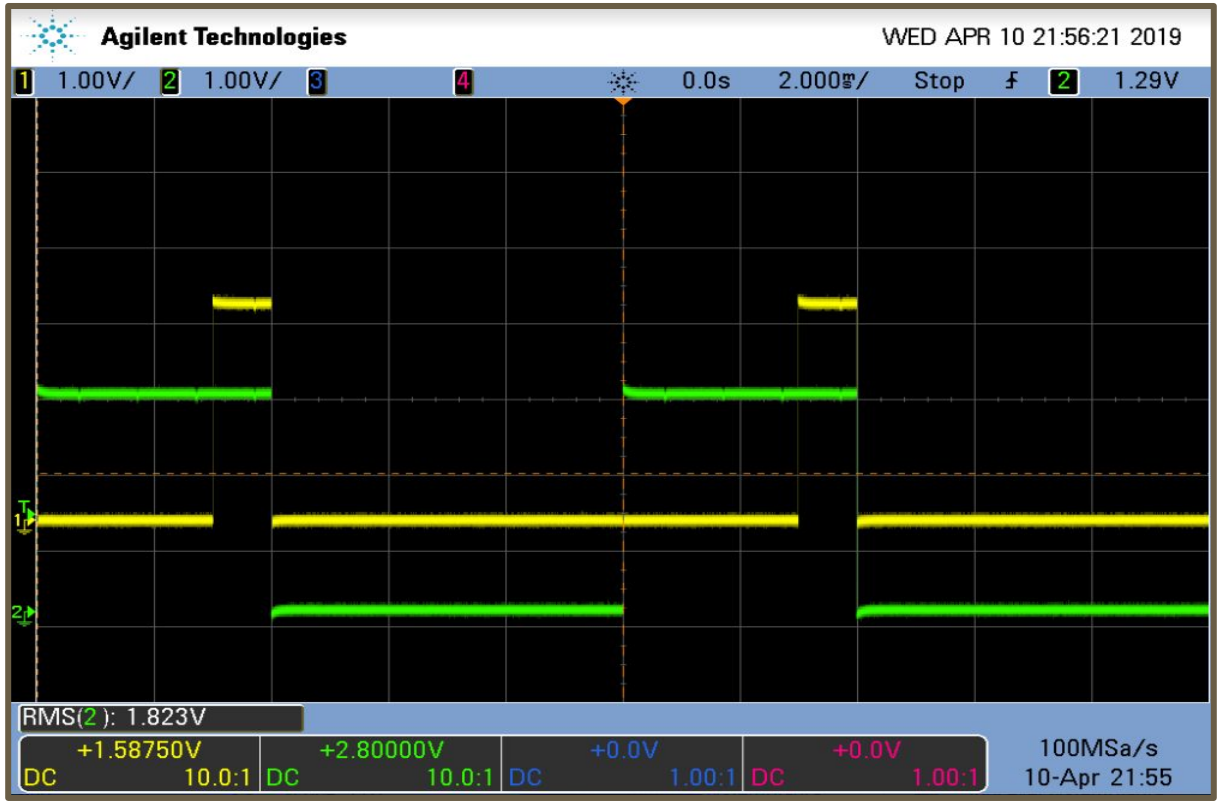
High Level Controller Design



PWM Driver Design



Dual Motor PWM control



Cost Summary

- $29 at non-bulk pricing
- $17 at bulk pricing

Device	Quantity	Product	Cost	Footprint	Product Link
Microprocessor	1	NRF52832-QFAA-R	$5.73	QFN48 (6 X 6)	https://www.digikey.com/pr
0.8pF Capacitor	1	500R07S0R8CV4T-ND	$0.02	0402	https://www.digikey.com/pr
12pF Capacitor	2	CC0402JRNPO9BN120	$0.01	0402	https://www.digikey.com/pr
100nF Capacitor	3	TMK105B7104KV-FR	$0.12	0402	https://www.digikey.com/pr
100pF Capacitor	1	C0402X6S0G101K020B	$0.30	0402	https://www.digikey.com/pr
4.7uF Capacitor	1	08034D475KAT2A	$0.60	0603	https://www.digikey.com/pr
1.0uF Capacitor	1	GRM188R70J105KA01I	$0.33	0603	https://www.digikey.com/pr
3.9nH Inductor	1	ATFC-0402-3N8B-T	$0.12	0402	https://www.digikey.com/pr
10uH Inductor	1	LQM18FN100M00D	$0.15	0603	https://www.digikey.com/pr
15nH Inductor	1	ATFC-0402-15NG-T	$0.12	0402	https://www.digikey.com/pr
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
IMU	1	LSM6DSLTR	$4.09	LGA-14(2.5x3x0.86)	https://www.digikey.com/prod
100nF Capacitor	2	TMK105B7104KV-FR	$0.12	0402	https://www.digikey.com/prod
10k Ohm Resistor	2	RNCP0603FTD10K0	$0.01	0603	https://www.digikey.com/pr
ToF	1	VL53L0CXV0DH/1	$4.10	VL53L0X (4.4mmx2.4mm)	https://www.mouser.com/Prod
100nF Capacitor	1	TMK105B7104KV-FR	$0.12	0402	https://www.digikey.com/prod
4.7uF Capacitor	1	08034D475KAT2A	$0.60	0603	https://www.digikey.com/prod
Motor Driver	1	595-DRV8835DSSR	$1.67	DRV8835 (2mmx3mm)	https://www.digikey.com/prod
1.0uF Capacitor	1	VJ0805Y105KXXTW1B	$0.03	0805	https://www.digikey.com/pr
Voltage Regulator	2	NCP699SN18T1G	$0.47	NCP699	https://www.digikey.com/pr
1.0uF Capacitor	4	CL05A105MQ5NNNC	$0.00	0402	https://www.digikey.com/pr
Battery Charger	1	BQ24090DGQR	$1.30	BQ24090	https://www.digikey.com/pr
1.0uF Capacitor	2	VJ0805Y105KXXTW1B	$0.03	0805	https://www.digikey.com/pr
1.5k Ohm Resistor	2	RR0510P-152-D	$0.10	0402	https://www.digikey.com/prod
1k Ohm Resistor	1	RR0510P-102-D	$0.10	0402	https://www.digikey.com/pr
2k Ohm Resistor	1	RT0402BRD072KL	$0.40	0402	https://www.digikey.com/pr
Attached LEDs	2				
Button Switch	1	1825910-6	$0.11	(6mmx6mm)	https://www.digikey.com/pr
.1uF Capacitor	1	08053C104M4T4A	$0.25	0805	https://www.digikey.com/pr
100k Ohm Resistor	1	ERA-2AED104X	$0.22	0402	https://www.digikey.com/pr
10k Ohm Resistor	1	RNCP0603FTD10K0	$0.01	0603	https://www.digikey.com/pr
Inverter	1	SN74AHC1G04DBVR	$0.43	SOT23-5 (2.9mmx1.6mm	https://www.digikey.com/pr
LED	1	QBLP677-RGB	$0.89	3.2mm x 2.7mm	https://www.digikey.com/pr
Battery 3.7V Nominal	1	ASR00003	$3.95	NA	https://www.digikey.com/pr
Micro USB Connector	1	UX60-MB-5S8(01)	$0.50	UX60-MB-5S8	https://www.digikey.com/pr
		Total Cost	**$29.09**		

Conclusions and Further Work

- Autonomous control based on ToF input
- Manual control with app input from Bluetooth
- Hardware connections intact
- Issues:
  - Processor module clock speed
  - Required libraries
  - IMU integration
  - Charging circuit
  - Motor wires

THANK YOU
to Petronics and ECE Course Staff